Prescribed Fire — Its Place in Reforestation ¹

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"There is an urgent need to inform the general public, resource managers, and conservationists about the historical role of fire in the forest and its proper place in wildland management."

Abstract

Forest fires have played an important role in determining the type and composition of forest ecosystems in the temperate region of North America. The close association between fires and forest ecosystems has helped the resource manager to interpret the significance of fire in reforestation, which in turn has induced him to use burning for this specific purpose. Until very recently, however, most of the burns in Canada have been carried out primarily for slash-fire-hazard reduction. Considerations in the planning and use of prescribed fire for hazard reduction and reforestation are inextricably linked and sometimes complementary. In addition to protection and reforestation objectives, prescribed burning should find wide application in the management of wildlife habitats and watersheds. Recommendations are made to assist resource managers and the public in appreciating more fully the present and potential role of fire in the forest ecosystems.

Le rôle du feu dans le reboisement

Résumé

Les feux de forêts ont joué un rôle important dans la détermination du type et de la composition des écosystèmes forestiers de la zone tempérée de l'Amérique du Nord. Cette relation étroite entre les feux et les écosystèmes forestiers facilite la compréhension de l'aménagiste sur l'importance du feu en repeuplement forestier de façon qu'il a songé à l'utiliser comme technique de reboisement. Jusqu'à tout récemment la plupart des feux provoqués volontairement ont servi surtout

à brûler les déchets de coupe afin de réduire les dangers d'incendies forestiers. Il n'en demeure pas moins cependant que cette action préventive reste encore étroitement liée à l'activité du reboisement. En plus des objectifs de protection et de reboisement, le feu contrôlé devrait servir davantage à l'aménagement des habitats de la faune et des bassins hydrographiques. Certaines recommandations sont faites pour aider les responsables et le public à mieux apprécier le rôle actuel et potentiel du feu dans le milieu forestier.

Wildfires of the past, particularly those in the conifer forests, have established and maintained several subclimax fire types such as pines and aspens. While extensive fires occurred in North America before the arrival of the white man, there is no doubt their frequency has greatly increased with settlement and timber harvesting. The close association between wildfires and some forest types in the temperate region has been reviewed and synthesized by several authors, but this information is not widely appreciated. Man's traditional fear of fire and his often inadequate and inaccurate knowledge about fire effects have prevented an objective assessment of its role in the past and its potential as a tool in forest management.

Extensive clear-cut areas with highly flammable slash provided the impetus for most of the big fires in the 19th and early 20th centuries. The disastrous consequences of those wildfires originating with settlers and loggers have, over the years, led to the

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practise of prescribed burning on forest lands. The main purpose of prescribed burning was the controlled reduction of slash hazard but with the important side-benefit of improved site for planting and seeding. By the 1920's, experimental and operational burning of slash for hazard reduction and reforestation was practised in several U.S. States and in some provinces including British Columbia, Ontario, and Newfoundland. In Finland and the Scandinavian countries, prescribed burning specifically for reforestation was carried out as early as 1875.

The role of fire in the forest

Fire has been the single most important disturbance in the temperate forest of North America. In Canada, nearly 2.5 million acres were burned over annually during the 10-year period 1957 to 1966. Wildfires have been particularly extensive in the boreal forests where homogenous flammable species such as pine and spruce extend over wide areas in unbroken continuity. Most pines, aspens, and several other species, sometimes referred to as fire climax, are dependent to a great extent on fire for their reproduction; in fact, fire has been the main regulatory force in determining the composition and geographical distribution of many forest types. Such fire-dependent forests are of great importance in Canada and efforts to significantly reduce fire incidence and damage must be balanced against present and future needs of fire protection, recreation, aesthetics, wildlife, silviculture, and watershed management.

In Canada, most stands, particularly in the boreal region, that are commercially important, originated after wildfires. Jack pine, lodgepole pine, and black spruce have serotinous or semiserotinous cones that require heat to open. These species, as well as Douglas-fir, western white pine and, to a lesser extent, red and eastern white pine, regenerate readily on fire-prepared seedbeds. Of the hardwoods, trembling aspen and white birch regenerate successfully after fire; the former from seed and by suckering, the latter from light, readily disseminated seed. In overmature forests with excessively deep accumulations of organic material overlaying the mineral soil and in northern areas with a continuous layer of permafrost near the ground surface, fire has a rejuvenating effect and returns the vegetation to a younger stage.

While fire is a sustaining force in tree reproduction and succession, it also affects all other forms of plant and animal life in the forest and these effects need to be viewed in proper perspective when setting reforestation priorities.

Objectives of prescribed burning in Reforestation

Prescribed burning is carried out primarily for slash hazard reduction and improvement in site for regeneration. Objectives of prescribed burning vary according to the needs of the forest manager. All or some of the following benefits may accrue:

- (a) Reduction of logging slash, plant competition, and humus before direct seeding, planting, scarifying or in anticipation of natural seeding in partially cut stands or in connection with seed-tree systems.
- (b) Reduction or elimination of unwanted forest-cover before planting or direct seeding, or prior to scarification plus planting or direct seeding.
- (c) Reduction of humus on cold, moist sites with concurrent increase in site productivity relative to regeneration.
- (d) Reduction or elimination of various fuels (slash, grass, brush, etc.) from strategic areas to protect reforested land against damage by accidental wildfires.

Status of prescribed burning in Canada

Burns to reduce hazard (Figure 1) are carried out when slash is dry enough to support a running fire without high risk to adjacent areas. These burns are usually carried out in early spring or late fall and generally accomplish secondary objectives such as facilitation of planting at desirable spacing, increase of soil-surface temperature, and release of nutrients to the seedlings.

Fig. 1. Prescribed burning on cut-over area.

Being light burns, they seldom expose mineral soil except on dry upland sites where the humus layer is usually very thin. Marked changes in depth of humus are likely only on a dry site with a shallow humus layer. Unless some trees are left as a seed source or seed is available from adjacent areas, the burned areas must be artificially regenerated.

On sites where the humus is thick, the objective of burning is often to reduce its depth and to partially expose the mineral soil. Owing to the large amounts of slash on these sites and the requirement for a long drying period to sufficiently reduce the moisture content of humus, these burns entail a greater element of risk and thus may be more expensive than the burns on areas with only a thin layer of humus. These high-intensity burns always reduce fire hazard and may contribute to site preparation objectives (Figure 2). Significant mineral

Fig. 2. Typical post-burn site and fuel conditions on cut-over area.

soil exposure by a single fire on deep, lowland humus or peat sites is unlikely. On all sites, only partial exposure of mineral soil is preferable and total burning of humus must be avoided. This applies particularly to sites of low productivity.

Nearly all recent operational burns in Canada have had hazard reduction and seedbed preparation as their objectives. Natural restocking on these sites depends primarily on timing and intensity of the burn, available seed source, type and density of post-burn vegetation, condition of seedbeds, depth of residual humus, quality of mineral soil materials, and weather that follows seeding. In recent years, planting has come to the forefront, as reforestation by this method does not depend on availability of seed from adjacent areas. Sometimes, burning is followed by aerial seeding.

Experimental burns are being conducted in different parts of Canada and in various forest types including lodgepole pine, jack pine, spruce-fir, red pine, white spruce-aspen, black spruce, Douglas fir, cedar-hemlock, hard maple, yellow birch and balsam fir. An increasing number of burning guidelines are becoming available to forest managers. These assist him in achieving well-defined goals relative to fire control, hazard reduction, and site amelioration. There is less information on benefit-cost relations and more studies are required. While prescribed-burning research has emphasized hazard reduction and reforestation, researchers are also investigating the role of fire in wildlife-habitat management and site conversion to desirable forest types.

Prescribed burning on cut-over areas has been tested in most provinces, but it is only in British Columbia where it is used to a meaningful degree (Table 1). This table was drawn up with data from published and private sources and is reasonably accurate.

Costs of operational prescribed burning vary directly with hazard and area and are difficult to compare across the country. Figures range from less than \$1 per acre for large hazard-reduction burns to over \$25 per acre on small, high-hazard silvicultural burns. The cost of slash burning in British Columbia averages about \$6 per acre. For

Table 1 Area of slash burned annually by prescribed fires in Canada, by province.

PROVINCE	AREA BURNED IN ACRES
British Columbia.....	100,000
Ontario.....	5,000
Manitoba.....	500
Alberta.....	less than 500
Nova Scotia.....	less than 500
Saskatchewan.....	less than 100
Quebec.....	less than 100
Newfoundland.....	less than 100
New Brunswick.....	none
Prince Edward Island.....	none

Ontario, the cost of burning for hazard reduction is reported to be less than \$1 per acre on clear-cuts of several hundred acres and from \$3 to \$5 per acre on smaller burns for silvicultural purposes. Prescribed burning for hazard reduction in jack pine slash in south eastern Manitoba costs about \$4 per acre.

The use of fire to achieve a specific purpose entails risks; one of them is damage to surrounding stands. The probability of prescribed-fire escapes increases with hazard and the cost of extinguishing these plus damage to adjacent timber must be considered as part of the total burning costs. For example, in the Vancouver Forest District these costs reportedly exceed \$30 per acre.

Any attempt to quantify expected benefits and costs associated with prescribed burning programs must involve consideration of complex short- and long-term effects on vegetation, topography, and land use. Direct costs of about \$5 per acre for slash burning compare favourably with over \$30 per acre for wildfire suppression plus damage. Nevertheless, uncertainty about fire escapes and effects has prevented a more widespread acceptance of prescribed burning as a tool in forest management. However, much uncertainty and hazard to surrounding stands can be reduced by fuller use of available information on fire behaviour and effects, increased training of personnel handling fires, more reliable fire weather forecasts, better use of drought indicators, and more effective ignition techniques.

As expected, the sense of uncertainty about prescribed-fire escapes and effects has prompted serious consideration of other approaches to hazard reduction and reforestation such as chemical, mechanical, and biological slash disposal.

The public's concern over air, soil, and water pollution makes it more difficult to utilize fire as a management tool. To overcome this problem, the public must be made aware of the beneficial effects of fire, particularly the benefits accruing from systematic slash-hazard reduction as a means of reducing uncontrolled and much more extensive wildfires. Adverse fire effects on soil and water quality are the result of indiscriminate use of fire in all situations. This, however, can be corrected by more careful definition of objectives and precise burning prescriptions. Research must be accelerated in the area of fire effects on forest ecosystems in general, and air, water, and soil quality in particular.

Conclusions

It is anticipated that prescribed burning in Canada will be confined primarily to clear-cuts, although limited use for manipulation of vegetation is likely. Prescribed burning to reduce probability of wildfires and to create satisfactory conditions for reforestation can be made complementary; differences relate mainly to burning objectives and conditions. Research is required to determine short- and long-term fire effects on forest ecosystems to facilitate prediction of burning results and to determine benefit-cost ratios of burning for fire protection, reforestation, and related land-use objectives.

The elimination of fire from the unmanaged forest is unnatural and will result in climax forest conditions which may not be desirable for recreation, the amenities, wildlife, or forest management.

Methods and Treatments Used To Secure Natural Regeneration in British Columbia

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Abstract

Natural regeneration will continue to play an important role in forest management practices in British Columbia despite the recent increase in artificial regeneration. It is anticipated that by the time the artificial regeneration programme has been fully developed, up to fifty per cent of the areas logged will be restocked artificially, leaving the other fifty per cent to restock naturally.

Méthodes et traitements en usage pour assurer la régénération en nature en Colombie-Britannique

Résumé

La régénération naturelle continuera à jouer un rôle important dans l'aménagement des forêts de la Colombie-Britannique, malgré l'essor récent de la régénération artificielle. On prévoit que lorsque le programme de régénération artificielle sera complètement développé, il répondra à 50% des besoins de régénération des superficies exploitées, laissant l'autre 50% à la régénération naturelle.

During the past decade, the scale of cut timber on the coast has increased 73 per cent while in the interior the scale has increased 90 per cent over the same period. The total volume removed in the peak year was 1,890,000,000 cubic feet⁽¹⁾. During the same period production of planting stock rose 180 per cent on the coast and 700 per cent in the interior. In the peak year, 35,700,000 trees were produced. By 1975 production is expected to increase

There is an urgent need to inform the general public, resource managers, and conservationists about the historical role of fire in the forest and its proper place in wildland management. These objectives can best be achieved through non-scientific publications, movies, television, and well-publicized demonstrations. Properly co-ordinated with fire prevention objectives, such a program should go a long way towards clarifying to the resource manager and the public the beneficial use of fire in the forest and its place in integrated land-use planning.

At northern fringes of the boreal forest, fire has played a prominent part in regulating the level of permafrost. Research should be initiated to clarify the effects of wildfires on the ecology of the tundra, particularly as they relate to site condition and productivity, plant succession, and wildlife populations.

to 75,000,000 trees annually. It is anticipated that the 75,000,000 trees will restock approximately 200,000 acres.

By 1975, if production trends continue, the annual cut will be in excess of 2,000,000,000 cubic feet. Under present standards of utilization, approximately 400,000 acres will be cut-over annually. This acreage could increase as poorer sites are harvested. It is, therefore, likely that at least 50 per cent of the acreage to be logged will be regenerated naturally.

In British Columbia, one tends to divide the Province into two major divisions, the coast and the interior, and to prescribe treatments on the basis of the forest types and their physical properties within these regions. Rowe's classification⁽²⁾ also segregates coastal and interior regions and provides a further means of relating silvicultural treatment to less-broad geographic areas.

Coast Region

Traditionally, clear cutting has been and will continue to be the preferred harvesting system on the coast. Many foresters in the southern Pacific coast section C.2 and minor parts of the Strait of Georgia, section C.1⁽²⁾, prescribe planting as the total regeneration method, even though coniferous stocking could be expected on many sites. The measure is taken, however, to influence stand composition, stocking density, regeneration period, individual tree growth and ultimately length of rotation. Some foresters, particularly in the western hemlock associations of the northern C.2 zone rely on natural re-